AD 416135

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA

U.S. ARMY BIOLOGICAL LABORATORIES
Fort Detrick, Frederick, Maryland

TECHNICAL MANUSCRIPT 85

STERILIZATION OF AIR FROM MICROBIOLOGICAL LABORATORY EQUIPMENT BY ELECTRIC INCINERATORS

The work reported here was performed under Project 4B11-05-015, "Protective Measures for Personnel Engaged in the BW Program," Task -01, "Safety Measures for Protection Against BW R & D Hazards." Expenditure order was 2021. This material was originally submitted as manuscript 5193.

G. J. Harris

G. G. Gremillion

P. H. Towson

Safety Division
OFFICE OF SAFETY DIRECTOR

Project 1C022301A072

August 1963

DDC AVAILABILITY NOTICE

Qualified requestors may obtain copies of this document from DDC.

Foreign announcement and dissemination of this document by DDC is limited.

The information in this document has not been cleared for release to the public.

ABSTRACT

Two models of an electric air sterilizer were tested for effectiveness in sterilizing air containing heavy concentrations of bacterial spores. The sterilizers are similar in design but differ in size and capacity. The smaller unit sterilizes air at 16 cubic feet per minute and the larger unit at 100 cubic feet per minute. The design contributes to long operational life and ease of maintenance.

I. INTRODUCTION

The study of respiratory transmission of infectious disease, using experimental infectious aerosols, creates problems in containment and disposal of the aerosol. These aerosols may be a hazard to laboratory personnel and to persons in adjacent areas. Similar problems with infectious microorganisms are encountered in handling dried micronized disease agents or in using small culture tanks.

The experimenters can be protected by enclosing the aerosol-producing device in a gas-tight enclosure that for additional assurance of safety is maintained at a negative pressure.[1] However, the air withdrawn from such an enclosure may be highly contaminated, and must be sterilized before it is discharged to the atmosphere.

Air can be sterilized by various methods such as ultraviolet radiation,[2] filtration,[3,4] and direct heat.[5] An electric incinerator suitable for sterilizing approximately one cfm (cubic foot per minute) of air has been described by Gremillion.[6] An electric grid type of sterilizer[7] for 100 cfm of air has been used at this installation. However, this latter type requires installation of an extended retention tube, and replacement of the heater element is difficult. When the grid heater breaks down, the sterilizer must be removed in order to repair it.

The design described in this paper overcomes these disadvantages by providing for a built-in retention tube and on-site maintenance and heater replacement.

II. MATERIAL AND METHODS

A. APPARATUS

The sterilizer design is scaled to two sizes. One sterilizes air in volumes up to 16 cfm; the other sterilizes up to 100 cfm. Each consists of five concentric cylinders of stainless steel (Figure 1) with Calrod heaters inserted into the central cylinder. The 16-cfm sterilizer has two Calrod #6A118G7 heaters (1750 watts, 230 volts) and the 100-cfm sterilizer has six Calrod #6A129G4 heaters (3000 watts, 230 volts). The outside cylinder is jacketed with two inches of insulation. The air is drawn in over the heaters and makes five passes back and forth before being discharged to the outside. An internally sensing thermoswitch controls the temperature to a preset level. The 16-cfm model is 30 inches long and 12 inches in diameter. The 100-cfm model is 58 by 20 inches.

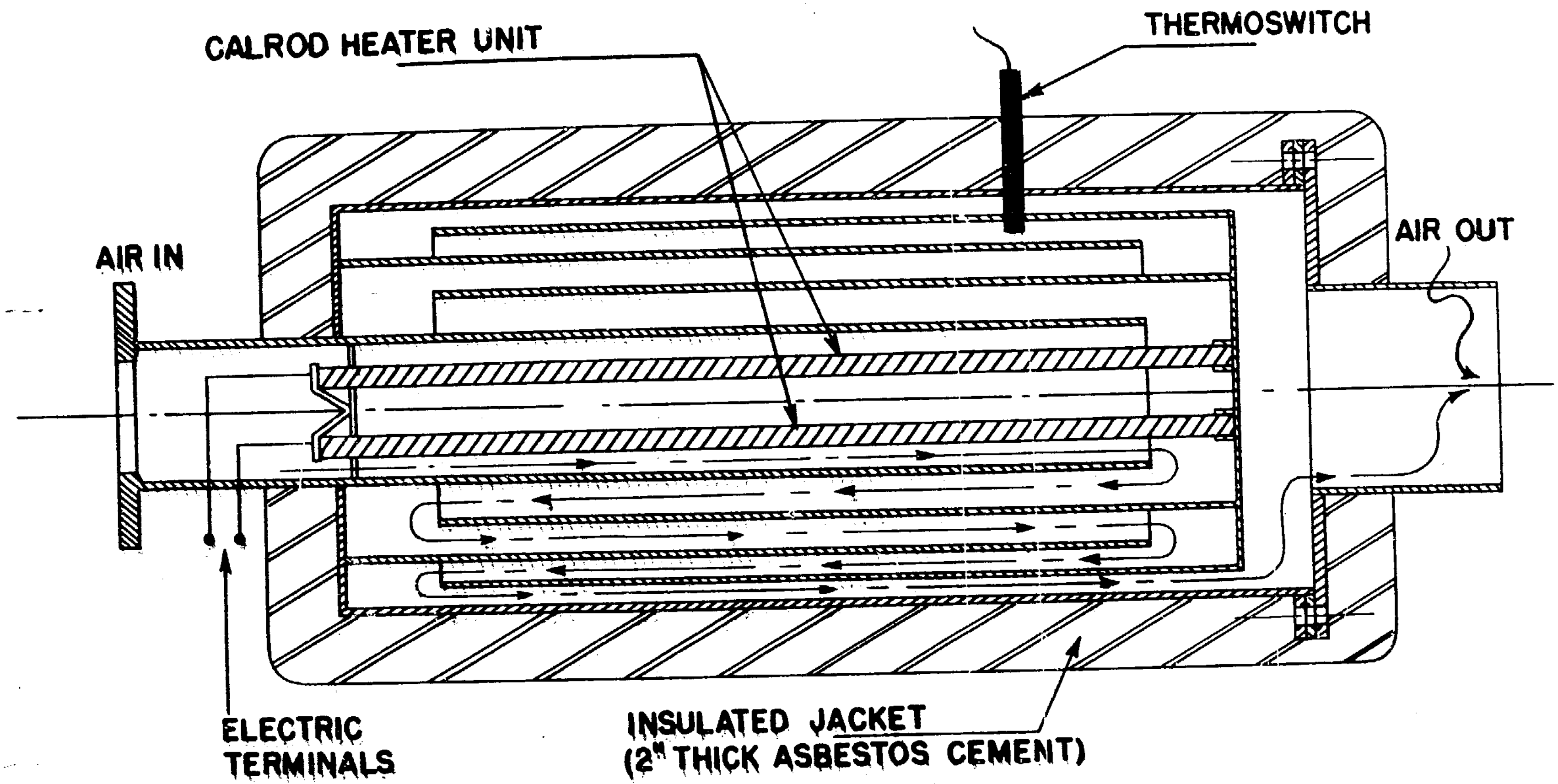

Figure 1. Electric Air Sterilizer Cross Section.

For testing, a one-cubic-meter aerosol chamber was attached by a length of round duct to the input end of the sterilizer. An airstream was passed through the sterilizer with an electric fan. The air flow was controlled by dampers.

B. EXPERIMENTAL METHODS

The sterilizer temperature and air flow were stabilized at the desired levels. Air flow was determined in the duct at the input end of the sterilizer by an Alnor Thermoanemometer, Type 8500. Temperature was measured in the duct six inches from the discharge using a thermocouple (iron-constantin) and a recording potentiometer. An aerosol of Bacillus subtilis var. niger spores was disseminated into the aerosol chamber with a Chicago-type nebulizer.[8] Before use, the suspension was heat-shocked at 80°C for 15 minutes. The concentration of viable spores in the aerosol (1×10^8 per cubic foot) was determined by sampling the contaminated air passing into the sterilizer with liquid impingers, serially diluting the impinger fluid, and plating samples on corn steep agar* surfaces in Petri dishes. Effluent air samples, withdrawn at a distance of one foot from the exhaust end of the incinerator, were passed through sieve-type samplers containing a solid impingement medium,* using the method of Decker.[7] Plates were incubated at 37°C for 48 hours. Aerosol generation and sampling were continuous throughout each test (30 minutes) at each temperature.

III. RESULTS

The results of these experiments are shown in Tables I and II. For tests with each size of sterilizer, the temperature was varied while air flow remained the same. The design air flow of 16 cfm was used for the smaller unit, 100 cfm for the larger.

The data show that the two sterilizers, when operated at design air flows, will sterilize air containing aerosol concentrations of spores of 1×10^8 per cubic foot. In some additional tests with the smaller unit at an air flow of 20 cfm, a maximum temperature of 330°F was recorded, and sterilization was not achieved.

---

* Black strap molasses, 10 grams; treated corn steep liquor, 30 grams; agar, 20 grams; distilled water, 1000 milliliters; adjust to pH 7.

TABLE I. STERILIZATION OF AIR CONTAINING SPORES OF B. SUBTILIS BY A 16-CFM STERILIZER

Temperature, °F	Spore Recovery[a/]	
	Test 1	Test 2
310	+	+
320	+	+
330	+	+
340	+	+
350	0	+
360	0	0
370	0	0
380	0	0
390	0	0

TABLE II. STERILIZATION OF AIR CONTAINING SPORES OF B. SUBTILIS BY A 100-CFM STERILIZER

Temperature, °F	Spore Recovery[a/]	
	Test 1	Test 2
376	+	+
383	+	+
386	0	+
389	0	+
402	0	0
419	0	0
422	0	0
425	0	0

a. Recovery of viable spores from duplicate tests of 30 minutes each. + = viable spores recovered. 0 = no viable spores recovered. Concentration of viable spores in air entering sterilizer = 1 x 10^8 per cubic foot.

IV. DISCUSSION

Laboratory experiments with infectious microorganisms sometimes require use of infectious aerosols, or such aerosols may be accidentally created by the equipment. Effluent air from these operations must be sterilized. The most effective treatment is incineration. The sterilizers described above are suitable for this purpose. The Calrod heaters are long-lived and can be replaced without disconnecting the sterilizer from its ductwork. The compact design requires no additional retention tube, which permits installation in a small space.

When operated at design air flow, each sterilizer contains reserve heating capacity to allow for some variation in air flow and for temporary power failures, up to 20 seconds in the 16-cfm unit and up to one minute in the 100-cfm unit.

LITERATURE CITED

1. Gremillion, G.G. "The use of bacteria-tight cabinets in the infectious disease laboratory," Proceedings of the Second Symposium on Gnotobiotic Technology 171-181, 1960.

2. Phillips, G.B., and Hanel, E., Jr. "Use of ultraviolet radiation in microbiological laboratories," Safety Division, U.S. Army Biological Laboratories, Frederick, Maryland. December 1960. (Technical Report 28). (Library of Congress PB 147043).

3. Decker, H.M.; Harstad, J.B.; Piper, F.J.; and Wilson, G.E. "Filtration of microorganisms from air by glass fiber media," Heating, Piping and Air Conditioning 155-158, May 1954.

4. Decker, H.M.; Buchanan, L.M.; Hall, L.B.; and Goddard, K.R. "Air filtration of microbiological particles," Public Health Service Pub. 953. U.S. Government Printing Office, Washington, D.C. 1962. 40 cents.

5. Sharpe, B.M. "Sterilizing germ-contaminated air by direct heating," Industrial Heating 21:745, 1954.

6. Gremillion, G.G.; Miller, L.F.; and Bodmer, G.A. "An electric incinerator for sterilization of small volumes of air," Appl. Microbiol. 6:274-276, 1958.

7. Decker, H.M.; Citek, F.J.; Harstad, J.B.; Gross, N.H.; and Piper, F.J. "Time temperature studies of spore penetration through an electric air sterilizer," Appl. Microbiol. 2:33-36, 1954.

8. Rosebury, T. "Experimental air-borne infections," Baltimore, Maryland, The Williams and Wilkins Co., 1958.